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On-Road Driving Assessment of Older Adults: A Review of the Literature

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EXECUTIVE SUMMARY

The components included in an on-road assessment will depend on the specific target group of older adults to be assessed and the intended purpose of the evaluation. Many different approaches are reflected in the literature and some well-developed standardized measures are available, though none are generally accepted as the "gold standard". The key features to be considered in designing or evaluating an on-road assessment procedure relate to ***course design*** (e.g., location of assessment, duration of testing, and route characteristics), and ***driving behaviors and scoring of driving errors*** (e.g., raters, subjective and objective measures). The characteristics of the route (e.g., four-way stop intersections, yield situations, merge situations) will necessarily influence the driving behaviors elicited and scored to determine the outcome of the assessment (e.g., pass/fail). The scoring mechanisms can be subjective ratings involving observation and some degree of judgment on the part of the examiner, or objective measurements, derived from instruments that record various aspects of driving behavior such as Global Positioning Systems, video-cameras, sensors, accelerometers, computers, and radar and video lane tracking systems. Other important considerations, when designing or evaluating older driver assessment procedures, include retraining and embedding on-road assessment within a broader comprehensive evaluation of driver safety.

INTRODUCTION

Exactly what constitutes driving ability and how to best assess it are issues that are as yet unresolved with respect to older drivers. It is apparent from the literature reviewed that driving is a complex task and on-road driving is one component of a more detailed comprehensive driving assessment process that is needed to fully evaluate the older driver's abilities and safety. This report will focus on issues related to on-road driving assessment. As yet, no "gold standard" for assessing on-road driving has been identified and used consistently in research related to older driver safety. Instead, a number of different approaches have been taken to on-road driving assessment that differ with respect to their procedures and intent. The purpose of this report is to describe the on-road driving assessment strategies articulated in the scientific literature relevant to older adults. In so doing, the key features related to ***course design*** (location of assessment, duration of testing, and route characteristics), ***driving behaviors and scoring of driving errors*** (raters, subjective and objective measures) and ***other important considerations*** relevant to older driver assessment will be addressed. A set of recommendations concerning the design and implementation of an on-road assessment program for older adults is provided.

METHOD

A systematic literature review of studies related to on-road driving assessment of older adults was conducted. The literature review focused on existing research relevant to on-road driving assessment, including both closed course and open road (i.e., in-traffic) methods, and issues related to scoring driving behaviors. Relevant research was identified by searching online databases including Psych Info, Ageline, Medline, the Web of Science, and Transportation Research Information Services (TRIS). An internet search was used to locate additional scientific literature via Google and Google Scholar and specific transportation research center websites. The following categories of search terms were used: 1) aging terms (e.g., older adults, older drivers, elderly, aged, seniors, elders); and 2) driving assessment terms (e.g., on-road driving assessment/test/evaluation/ examination/track; driving errors/mistakes, fitness to drive, driving performance, methods/types of driving assessment). The literature search was restricted to research published between 1990 and 2007.

In most of the reviewed literature, on-road driving assessments were used to study the relations between driving and other off-road assessment methods (e.g., neuropsychological tests, driving simulators) or to compare differences in driving performance across diagnostic groups (e.g., dementia, stroke, healthy elderly; Fox, Bowden, & Smith, 1998). Fewer studies specifically addressed the development of on-road assessment methods to predict the actual driving performance (real world driving) of older adults. For the purposes of this report, we have extracted the key elements of ***course design and*** the evaluation of ***driving behaviors*** (e.g., scoring of driver errors)

from these various types of studies. In addition, we have included a brief section highlighting other important considerations relevant to older driver assessment.

RESULTS

Target Population

The population of older adults aged 65 years and over is a heterogeneous group. Healthy aging and many age-related diseases are associated with declines in sensory/perceptual, physical/psychomotor and cognitive abilities that may compromise one's ability to drive safely (Anstey, Wood, Lord, & Walker, 2005; Eby, Trombley, Molnar, & Shope, 1998). It is apparent from the literature that most discussion around driving assessment for older adults has focused on detecting those drivers with cognitive impairment who are unsafe to drive. Various groups (e.g., physicians, policy makers) have developed practice guidelines acknowledging the importance of addressing the driving practices of people with disorders that affect cognitive functioning (Dubinsky, Stein, & Lyons, 2000; Johansson & Lundberg, 1997; Australian Society for Geriatric Medicine, 2003; Patterson et al., 2001). However, it is also clear that medical conditions affecting other aspects of functioning (e.g., vision, physical/motor functions) may affect driving as well, but perhaps in different ways. That is, driving ability may be differentially impacted in various groups of older adults. Given the breadth of disorders that may affect driving, the Canadian Consensus Conference on Driving Evaluation of Older Drivers recommended that referral for driving assessment is appropriate when there is uncertainty about ability to drive safely due to health related factors (Korner-Bitensky, Gelinas, Man-Song-Hing, & Marshall, 2005). The consensus group strongly agreed that these referrals for assessment should include, but not be limited:

1) to those who have medical conditions that impact functioning (e.g., vision, hearing, musculoskeletal, mental or neurological health); and
2) to specific diagnostic groups in which driving is frequently compromised (e.g., stroke, Parkinson's disease, mild-to-moderate dementia, cognitive decline, or diabetes with peripheral neuropathy (Korner-Bitensky et al., 2005).

Another group appropriate for on-road driving evaluation is older adults who are either seeking or being referred for driving re-training. Research on older drivers has emphasized the need for interventions to increase older driver safety. A recent systematic review of existing older driver training programs found evidence indicating educational programs improve driver awareness and driving behavior, but do not necessarily reduce crash rates (Kua, Korner-Bitensky, Desrosiers, Man-Son-Hing, & Marshall, 2007). It has been suggested that older drivers need educational programs to teach compensatory driving strategies (De Raedt & Ponjaert-Kristoffersen, 2000) and to enhance proactive planning (Marottoli et al., 1998; Rudman, Friedland, Chipman, & Sciortino, 2006). On-road driving assessment may be used to identify individuals who may benefit from driver re-training and to identify particular driving behaviors as the focus for driver re-training (Fox et al., 1998). Several studies have examined post-intervention changes in on-road driving performance of older drivers (Ashman, Bishu, Foster, & McCoy, 1994; McCoy, Tarawneh, Bishu, Ashman, & Foster, 1993; Ostrow, Shaffron, & McPherson, 1992)

The components included in an on-road assessment will depend on the specific target group of older adults to be assessed and the intended purpose of the evaluation. For example, many hospitals or rehabilitation centres employ driver rehabilitation specialists (DRS), often occupational therapists, who are skilled in physical rehabilitation and vehicle modification to accommodate physical disability. The driving assessments they perform have been developed through clinical judgment and are based on subjective criteria. Often the goal of driving assessments conducted in these settings is rehabilitative in nature, focusing on the individual's driving goals, and assessing driving in situations relevant to those goals. This rehabilitative approach is likely to be of assistance in identifying the driving strengths and weaknesses of the individual and possible driving re-training strategies for that individual.

If the intent of the assessment is to reach a decision about the general driving safety of the person, other approaches may be necessary. Such a decision requires that a comparison be made to 'reasonable road safety', or to the performance of experienced healthy drivers in similar driving situations. This requirement arises from a Supreme Court of Canada ruling that standards for testing a driver with a disability cannot require a level of driving safety that exceeds 'reasonable road safety'. Reasonable road safety denotes the level of road safety of healthy drivers who are permitted to drive. This ruling does not imply that driver evaluation necessarily be the same for healthy and disabled people; rather it only specifies that a higher standard of driving safety cannot be required for disabled people than is required for healthy drivers.

Course Design

From the literature reviewed, it is clear that there are large differences in on-road assessment practices in terms of on-road course design. This includes the ***location*** where testing tasks place (e.g., closed course versus open road), ***duration*** of the assessment (30 minutes to over 90 minutes), and ***route characteristics***. The characteristics of the route (e.g., four-way stop intersections, yield situations, merge situations) will necessarily influence the driving behaviors elicited and scored to determine the outcome of the assessment (e.g., pass/fail). ***Driving behaviors,*** and methods by which they have been scored, will be discussed after the key features of course design are examined.

Location

Within the literature reviewed, distinctions have been made between *closed course* and *open road* in-car on-road driving evaluations. A ***closed course***, or circuit, is a route defined in a non-traffic or low traffic environment. Closed courses have been used for two purposes: 1) to assess whether a client meets minimum standards of competence for an open-road assessment (i.e., basic maneuvering or operational level skills; Fox et al., 1998) and 2) to assess more complex operational aspects of driving such as non-routine (emergency) driving events (Dobbs, 2005). All ***open road*** evaluations take place in

normal traffic situations, but may vary with respect to length, duration, and route characteristics.

When examined in relation to open road driving performance, closed courses have yielded little additional information to that obtained in traffic (Dobbs, 2005; Fox et al., 1998). Moreover, closed courses are necessarily limited in that they do not provide information about driver's ability to interact with complex traffic patterns (Odenheimer et al., 1994). In this way, they lack ecological validity. Closed course performance may not generalize to "real world" driving for a number of reasons, perhaps the most salient of which is that there is greater time for compensation of slowed reaction time to take place. However, closed course evaluation may provide valuable information about car handling skills and readiness to interact with traffic.

Duration

Professionals attending workshops at the Association of Driver Educators for the Disabled (ADED) annual conference responded to survey questions on the process and structure of their driving evaluation practices (Korner-Bitensky, Bitensky, Sofer, Man-Son-Hing, & Gelinas, 2006) and 99 percent reported using on-road assessments greater than 30 minutes in length, with 50 percent reporting length as 30-60 minutes and 49 percent indicating greater than 60 minutes. Participants in the Canadian Consensus Conference on Driving Evaluation of Older Drivers agreed that a 45-60 minute on-road evaluation generally provides sufficient time to assess various on-road driving maneuvers and behaviors. However, they noted (i.e., strong consensus) that the driver evaluation might need to be cut short if the evaluator or instructor perceives a threat to safety of the individuals in the vehicle.

Route Characteristics

Another distinction that has been made within the literature reviewed is whether a driving assessment route is ***standard*** (e.g., same components included in every assessment) or not. From the ADED surveys, it was evident that, of the 94 percent of respondents who reported performing on-road evaluations when assessing older drivers, the majority used standard or fixed routes. Of note, a greater percentage of respondents indicated use of a standard route in 2003 (78% said yes) than in 1997 (65% said yes).

The key ***route characteristics***, or critical situations, included in an open road test have varied from study to study. Typically, they are chosen to reflect situations in which older adults report difficulty (Mallon & Wood, 2004) or that represent situations where normal older adults, or older adults with medical conditions, have demonstrated difficulty (Dobbs, 2005). Participants in the Canadian Consensus Conference on Driving Evaluation of Older Drivers made a number of recommendations about *open road* course design (see Table 1). In addition, strong consensus was reached concerning the observation that, while existing on-road assessments had many good features, none addressed the entire driving task.

Table 1. Critical Components of an on-road driving assessment route
Strong Consensus
Four-way stop intersections
Two-way stop intersection
Left turns
Right turns
Stop sign
A merge that requires an increase in speed
Roadway requiring lane positioning
Route requiring changing of lanes
Roadways requiring varying speeds to > 70 km/hr
Yield situation (sign where available)
Environment requiring backing up
Following another vehicle
Moderate Consensus
Traffic lights
Merging speed of 70 km/hr plus
Parallel parking not a critical component (required in some provinces)

The strong agreement reached at the consensus conference on many of the critical characteristics of an on-road assessment route provides a basis for a core set of elements for sites to consider when assessing older drivers.

Another distinction made in the literature concerning in-car, on-road driving evaluations is whether or not they are ***standardized.*** A ***standardized*** driving evaluation involves a set, or fixed, route designed to fulfill requirements for traffic density and specified driving behaviors (e.g., maneuvers) that may be reproduced in other locations. The developers of these evaluations argue that knowledge beyond personal observation and consensus opinion is needed, and the scientific method provides a means to acquire that knowledge. These test developers each address the need for validated performance-based driving evaluations that may serve as a basis for driving recommendations that are fair and consistent. For each of these evaluations, specific ***driving behaviors*** (see below) are observed, broken into components, and rated, often several times. The properties of the evaluation are examined to address issues of reliability (i.e., the same results will be obtained on repeated assessments or with different raters) and validity (i.e., the outcome evaluation distinguishes between groups of drivers or relates to other measures of driving ability). Some evaluations have been developed more thoroughly than others. Examples of standardized driving evaluations are summarized in Appendix A.

It is important to note that from the reports of professionals in the ADED study (Korner-Bitensky et al., 2006), only two respondents used a published (standardized) road test, in both instances the Miller Road Test (see below; Carr, Jackson, Madden, & Cohen, 1992) The authors speculated that the cost of these tools may be prohibitive or they may be lacking in terms of practicality or face validity.

The Vehicle

Another issue related to course design is the vehicle in which the driver undertakes the evaluation. Although it has been argued that drivers are disadvantaged if not allowed to drive their own cars, there are a number of advantages to using the same vehicle (i.e., examiner's car) for each evaluation. First, the use of the same car contributes to the standardization of the evaluation process by ensuring that the technical specifications of the vehicle are the same for each participant. Perhaps most importantly, cars with dual-control brakes or control adaptations (e.g., engine switch-off) enhance the safety of those in the vehicle. In addition, if the car is fully modifiable, the driver can try various adaptations before engaging in open road evaluation and before investing in adaptations to his/her own car.

Critical Driving Behaviors and Scoring of Driving Errors

Critical Driving Behaviors

As noted earlier, the characteristics of the route will necessarily influence the driving behaviors elicited, or maneuvers undertaken, and scored to determine the outcome of the assessment (e.g., pass/fail). In the literature reviewed, a number of different critical driving behaviors, or maneuvers, were identified as important. For example, Justiss, Mann, Stav, & Velzo's (2006) behind-the-wheel driving assessment involved broad, general categories of critical behaviors. Their categories were as follows:

1) Vehicle position (e.g., the position of the vehicle forward and backward in relation to other vehicles, objects and pavement markings);
2) Lane maintenance (e.g., lateral position of vehicle during driving maneuvers and while stopped);
3) Speed regulation (e.g., ability to follow speed limits and control over acceleration and braking of the vehicle);
4) Yielding (e.g., giving the right of way);
5) Visual scanning of the driving environment;
6) Gap acceptance (e.g., choosing the safe distance to cross in front of oncoming traffic); and
7) Adjustments to stimuli/traffic signs (e.g., the ability to respond appropriately to driving situations).

Other studies have used more specific maneuvers (e.g., left hand turns, yields, merges, lane changes) selected because of their associations with older driver crashes. Although there is wide variation in the types of critical behaviors used across studies, the members of the Canadian Consensus Conference on Driving Evaluation in Older Drivers reached strong consensus that certain critical driving behaviors should be included in a comprehensive driving evaluation (Table 2).

Table 2. Critical Driving Behaviors of an on-road driving assessment
Strong Consensus
– Speed maintenance at various speeds according to road conditions and in respect of signage – Maintaining lane positioning – Stopping at red traffic lights – Stopping at stop signs – Not stopping at green lights – Merging at appropriate speed with visual scanning and awareness of critical stimuli – Appropriate lane positioning during turns Backing up–awareness of surrounding stimuli by checking behind both sides – Slowing to potential hazards – Yielding where appropriate – Not spending excessive time at intersections – Respecting a "space cushion" around the car, that is, the distance in front and back of the vehicle and also on either side of the vehicle – Maintaining driving performance with introduction of "cognitive burden" (for example, responding to conversational questions from the evaluator)

Scoring of Driving Errors

Scoring procedures used to evaluate the on-road driving performance of an older adult vary considerably. There are a number of scoring issues related to ***the rater*** (e.g., how many raters are needed and who should do the rating) and the ***scoring mechanism/rating system*** used (e.g., subjective evaluations and objective measures).

The Rater

Some on-road assessments have used a single rater to score driving performance, while other studies have used multiple raters (Fox et al., 1998). Fox et al. (1998) recommend that a driving instructor be seated in the front seat to provide instructions to the driver and to intervene if necessary to maintain vehicle safety. Meanwhile, the back seat rater can devote all their attention to observing and rating the driving maneuvers performed by the examinee. In addition, as Fox et al. (1998), note this permits the rater to have a better view of some critical aspects of driving that cannot be properly viewed from the front seat (e.g., visual scanning). On the other hand, others (e.g., Justiss et al., 2006) have developed scoring procedures that allow one rater to both adequately observe driving behaviors and intervene to maintain vehicle safety. Justiss et al. (2006) developed a driving performance form (i.e., checklist of errors under specific maneuvers), based on feedback from driving rehabilitation specialists, so a single evaluator could observe and rate driving errors and attend to the driver and driving environment simultaneously.

Often the raters are driving instructors, researchers or occupational therapists. It is widely agreed that a comprehensive driving assessment, of which on-road assessment is a component, should be conducted by a health professional that has specific expertise in

driving evaluation (Korner-Bitensky et al., 2005). In the United States, the term driver rehabilitation specialist is used to identify an individual who plans, develops, coordinates and implements driving services for individuals with disabilities (American Medical Association, 2003).

The Scoring Mechanisms

The scoring mechanisms used to assess driving performance can be divided into ***subjective ratings*** and ***objective measurements*** of driving performance. Subjective ratings include scoring methods that involve observation and some degree of judgment on the part of the examiner. Objective measurements are derived from instruments that record various aspects of driving behavior such as video recorders or Global Positioning System (GPS) technology, thereby eliminating, or greatly reducing, the need for subjective judgment on the part of the examiner. The type of route used in the assessment influences validity of the scoring procedures. In their discussion of scoring procedures used in driving evaluation of brain injured populations, Fox et al. (1998) point out that scoring driving behaviors on non-standard routes produces results of questionable validity, because each driver that is assessed is not exposed to the same opportunities for making driving errors. Another critical issue related to scoring driving performance was raised by Brown and Ott (2004) who point out that it is not always possible to assess and to ascertain how an older driver would handle some driving errors because the evaluator must intervene to maintain their own safety under certain conditions.

Subjective Ratings

In the literature reviewed, a wide variety of ***subjective*** methods of scoring driving procedures have been employed. The range of procedures used has varied from simple tallies of errors (or correct maneuvers) made and time taken to execute particular maneuvers, to more elaborate rating procedures of global performance or individual driving behaviors (e.g., recording type, severity and location or error, qualitative descriptions or rating scales; (e.g., recording type, severity and location or error, qualitative descriptions or rating scales; Fox et al., 1998). Rating scales may vary from 2 point (e.g., safe/unsafe or correct/incorrect) to 5 point scales or larger (Dobbs, Heller, & Schopflocher, 1998; Fox et al., 1998; Justiss et al., 2006; Mallon & Wood, 2004). Often assessment of driving performance is based solely on clinical judgment, therefore, leaving room for discrepant evaluations across different raters (Dobbs, 2005). As discussed above, standardized methods of testing and scoring improve the validity of on-road evaluation (Dobbs, 2005; Fox et al., 1998).

Objective Measurements

Objective assessment of driving performance is made possible by the use of instrumented vehicles (Rizzo, Jermeland, & Severson, 2002). An instrumented vehicle is equipped with instrumentation to take recordings of a variety of aspects of driving (Rizzo et al., 2002). These technologies include GPS, video-cameras, sensors, accelerometers, computers, and radar and video lane tracking systems. An instrumented vehicle can be differentiated from a dual-brake vehicle that is equipped with controls to allow

intervention by the examiner. The technologies used in instrumented vehicles can be used in conjunction with ratings by a driving evaluator or without an observer in the car. The latter allows for driving to be assessed in a more naturalistic way by eliminating the concern that drivers might alter their driving behavior due to awareness of their evaluation (Baldwin, Duncan, & West, 2004; Porter & Whitton, 2002). Many of the devices used (e.g., GPS receivers, the Driving Monitor System) are relatively inexpensive and can be installed fairly easily (Baldwin et al., 2004; Porter & Whitton, 2002). Using a combination of GPS and video cameras allows for measurements of vehicle position, heading, velocity, acceleration, and deceleration to be obtained, and lane changes, distance to oncoming cars, and head motion (depending on where the cameras are mounted) to be monitored. All modern vehicles record speed, emission controls, and vehicle performance, while some "smarter" cars allow reporting of additional items including seatbelt use, headlight use, climate and traction control, wheel speed, and ABS activation (Rizzo et al., 2002).

Classification Systems

Following an on-road driving assessment, older driver are often provided with an overall or global classification of driving typically, though not always, determined by subjective evaluation by the examiner, rather than based on a quantified overall driving score (Justiss et al., 2006). Often this global classification is a simple pass/fail or safe/unsafe (Fox et al., 1998; Justiss et al., 2006). Others suggest broader classification systems that identify those with potential for remediation. For example, Justiss et al. (2006) rated overall performance on their behind-the-wheel assessment on a 4 point scale: safe (3) safe with restrictions or recommendations (2), unsafe remediable (1) and unsafe not remediable (0). Participants in the Canadian Consensus Group on Driving Evaluation of Older Drivers strongly agreed that evaluation outcome be classified into three categories: Pass (performed safely); Poor/Indeterminate (with possible potential for remediation); and Do Not Pass (unsafe/non-remediable; Korner-Bitensky et al., 2005).

Other important considerations in the assessment of older drivers

Retraining

Incorporating retraining into open road evaluation is another approach to driving assessment that was proposed by Brouwer and Von Zomeren in 1992. They suggested training impaired drivers in strategic (e.g., route planning) and tactical level (i.e., maneuvers) compensatory behaviors until training goals are reached or a preset maximum number of lessons is exceeded. In this context, unsafe driving would be defined as the inability to reach the criterion as a safe driver within the limits of available training and technical adaptations. This approach has the advantage of "building in" retaining to the driving assessment procedure so that the driver is given every opportunity to improve. The disadvantages of this approach are the potential cost of providing the lessons, especially since there is little published research to guide in the implementation of such a program.

Other components of a comprehensive older driver evaluation

There are many related assessment procedures that are employed to evaluate or predict real world driving performance. These include office-based assessments of driving-relevant abilities (e.g., cognitive, physical, motor, health related factors and medical conditions), tests of driving specific knowledge (e.g., rules of the road, traffic sign recognition), driving simulator testing, and self assessment or report from others (e.g., questionnaire about driving ability, computerized self-assessment programs). Although many of these procedures (e.g., performance on cognitive measures or driving simulators) have not been found to reliably predict real-world driving performance (e.g., Dubinsky, Stein, & Lyons, 2000; Duchek et al., 2003; Whelihan, DiCarlo, & Paul, 2005), the participants of the Canadian Consensus on Driving Evaluation in Older Drivers recommend that a comprehensive driver evaluation is needed and that it include both off- and on-road methods of evaluation (Korner-Bitensky et al., 2005). The group achieved moderate to strong consensus regarding the components to be included in a comprehensive driving evaluation (Table 3). For specific choice of tools to be included in the off-road assessment portion of a comprehensive driver evaluation, see Korner-Bitensky et al. (2005). A discussion of the advantages and disadvantages of these related assessment methods is outside the scope of this report but the strengths and weaknesses of these methods can be found in the papers by Fox et al. (1998), Rizzo, Reinach, McGehee and Dawson (1997), Rizzo, McGehee, Dawson and Anderson (2001), and The British Psychological Society (2001).

Table 3. Comprehensive Driving Evaluation

Strong Consensus
Pre-road driving assessment should be conducted by same individual who is conducting the on-road assessment.
The pre-road driving assessment should include measures of cognition, visual perception, and physical and motor status.
Driving specific information should be gathered including driving history, medical history, self-perception of driving performance, and physical and motor status.
A comprehensive test of driver knowledge should be included in a pre-road assessment.
Moderate Consensus
The pre-road driving assessment should include measures of vision, reaction time, and behavior.
An on-road driving assessment should not be conducted if poor results are obtained on pre-road assessment tools.
A closed route course should be conducted with individuals whose pre-road assessment suggests a high risk.

Limitations of on-road assessment

On-road driving assessment has several important weaknesses including increased safety risk for the driver, examiner, and other road users and possibly biased evaluations (e.g.,

Fox et al., 1998; McKenna, Jefferies, Dobson, & Frude, 2004; Schultheis, Hillary, & Chute, 2003). In addition, standard on-road examination procedures may involve less demanding environmental conditions (e.g., predetermined routes, less busy times) and decision making processes (e.g., instructions/cues provided by examiner) compared to the real world (Shultheis et al., 2003; The British Psychological Society, 2001). Moreover, driving observed during an on-road testing situation may not accurately represent an individual's true behavior in everyday driving situations (e.g., more caution, motivation to drive safely, awareness of evaluation; Fox et al., 1998; Pietrapiana et al., 2005; The British Psychological Society, 2001). Despite these disadvantages, open road driving assessment is generally agreed upon as the most ecologically valid method to evaluate driving ability of older drivers, particularly if undertaken within the context of a comprehensive older driver evaluation.

CONCLUSIONS

The components included in an on-road assessment will depend on the specific target group of older adults to be assessed and the intended purpose of the evaluation. Many different approaches are reflected in the literature and some well-developed standardized measures are available, though none are generally accepted as the "gold standard".

RECOMMENDATIONS

Most of the following recommendations are made based on the assumption that the intent of the on-road driving assessment is to make recommendations regarding the safety of older drivers. We have made these recommendations under the headings contained in the body of the report. It is recommended that:

Target Population

- the target population that will take part in the older driver assessment and the purpose of the assessment be clearly articulated and defined. The requisite elements for inclusion in the assessment will be dependent on the target group(s) and the purpose;

Course Design

- a brief closed course examination of vehicle handling skill precede any on-road driving assessment to identify those with inadequate skills to enter traffic and to allow for vehicle modifications to be fitted for those that need them before entering traffic;
- a 45-60 minute on-road evaluation be employed;
- the Critical Components of an On-Road Driving Assessment from the Canadian Consensus Conference on Driving Evaluation in Older Drivers be used in the development of on on-road assessment for use with older adults. This will allow for consistency with other sites across Canada and facilitate international interactions;
- the critical components (i.e., route characteristics) selected for the assessment should not be so difficult as to contrast unfavorably with ordinary licensing test

but challenging enough to allow manifestation of any cognitive or perceptual deficits incompatible with safe traffic participation;
- a standardized procedure that has a fixed route with predefined driving behaviors (maneuvers) and scoring criteria be used. This procedure should be conducted in the same manner for all older drivers to the extent possible given constraints due to disability and should be conducted in as similar an environment as possible. It is imperative that assessments used for making recommendations regarding the safety of drivers be reliable and valid;
- driver retraining be built into the assessment with a maximum number of lessons specified before retraining is terminated;
- a dual control car that is fully modifiable be used to conduct on-road driving assessments. This is essential for safety reasons and safety overrides concerns about validity of using vehicle unfamiliar to driver;
- a self-directed navigation component be considered for inclusion in the assessment. This task requires the participant to actively engage in multiple tasks involving visual scanning, divided attention, planning and judgment. This requires a much higher degree of cognitive and visual ability than simply following directions;

Critical Driving Behaviors and Scoring of Driving Errors

- the Critical Behaviors During On-Road Driving Assessment from the Canadian Consensus Conference on Driving Evaluation in Older Drivers be used in the development of an on-road assessment for use with older adults. This will allow for consistency with other sites across Canada and facilitate international interactions;
- the driving behaviors sampled for use in the assessment must be sufficient in terms of duration and complexity to allow observation of several driving situations and maneuvers. This will enhance reliability and validity;
- two raters, a driving instructor seated in the front seat to provide instructions to the driver and to intervene if necessary to maintain vehicle safety and an independent rater in the back seat, be employed to ensure accurate scoring of driving errors;
- other technologies be used only as determined by the purpose of the assessment;
- there be a large number of independently scored items, to enhance reliability and provide independence of one score from the next;
- the scoring procedure be simple with specification of the correct responses to enhance reliability and ensure identical standards of performance are used for each assessment;
- the outcome of the driver assessment be classified into three categories: Pass (performed safely); Poor/indeterminate (with possible potential for remediation); Do Not Pass (unsafe/non-remediable);
- specific information about driving behaviors be obtained to determine needed vehicle modifications, training requirements and compensatory potential.

Other important considerations in the assessment of older drivers

- in keeping with the Canadian Consensus group, related off-road assessment procedures, along with an on-road evaluation, be considered for inclusion in a comprehensive driving evaluation of older adults;
- off-road/pre-road driving assessment procedures not be used to make a decision about an individual's driving safety on their own;
- off-road assessment methods be used to screen for individuals who might be appropriate for on-road driving testing or to supplement information provided by an on-road assessment;
- research on the development and implementation of an older driver assessment program be undertaken to:
  - ascertain validity of the assessment procedure for ethical and legal purposes;
  - monitor and improve program design (ongoing program evaluation);
  - examine driving ability in different diagnostic groups (e.g., dementia, stroke, TBI) with the aim of characterizing deficient driving skills ;
  - examine the relations between off-road assessment procedures (e.g., psychological and medical tests) and on-road driving performance;
  - examine the criterion validity of standardized on-road assessment including sensitivity and specificity of judgment of safe driving as this is an area that requires further development in healthy as well as impaired populations;
  - examine on-road assessment as a criterion measure for intervention/training effects (e.g., classroom education, simulators training, etc).

Appendix A: Selected standardized measures

Name	Developer	Where used	Description
Driver Performance Test	Jones (1978)	University of Southern California	-reliability and standardization was examined in normal drivers; - standardized route, several critical maneuvers rated several times,; -observation of about 110 items of behavior -administered to various groups of drivers (e.g., different ages) and examined for test-retest reliability
The Miller Road Test	Carr et al. (1992)	Washington University, St. Louis, Missouri	-used with older and younger adults -not conducted within the complexity of an open-road environment
Performance-based Driving Evaluation (PDE)	Odenheimer et al. (1994)	Geriatric Research Education and Clinical Center, Department of Veterans Affairs, West Roxbury, Massachusetts	-a fixed route, in traffic, and in range of driving situations; -68 scored tasks -the correlation between the in-traffic score on the PDE and a driving instructor's global rating was .74.
	Fitten et al. (1995)	Department of Veterans Affairs, California	-hospital internal roadway to ensure low-level traffic conditions; -2.7 km in length; -six stages, each presenting a different degree of driving complexity; -wide-angle camera on mounted on the roof of the car; -scoring criteria for specific performance and more general aspects of driving.
The Washington University Road Test	Hunt et al. (1997)	Washington University, St. Louis, Missouri	-partially standardized evaluation where the driver follows a pre-determined route in low-volume traffic.
The DriveABLE Road Test	Dobbs et al. (1998)	Developed in Edmonton; now used in many provinces and	-most well-developed of the standardized road tests; -Originally, consisted of a closed course with emergency-type

		states	situations and an open road course with a driving instructor and an observer in the car as well as video recorders mounted on the car (one to record driver, one to record the road); -dual control car used; -people of different age groups and older adults with and without cognitive impairment; -participants also administered neuropsychological and rehabilitation evaluations to ensure the control participants were mentally and physically normal; -this information was also used to examine the relations between these measures and the open road measures; -150 driving errors were scored - - -the errors that distinguished between normal and impaired groups were identified as competence-defining errors; -frequency, severity and locations in the course where these errors were made were examined and used to set rules for laying out a road course that would have the attributes necessary for effective evaluations of medically at-risk drivers; -to avoid discrimination, the fail criterion was set so that the person was making errors that place him outside the range of competence-defining errors displayed by healthy, normal drivers in that situation. -closed course and self-directed navigation instructions (i.e., take me to …) did not contribute to the discrimination of the impaired versus healthy groups and so were abandoned;

			-have tackled a number of the challenges of standardization, including the need for procedures to ensure every person receives the same evaluation outcome regardless of testing site and the constant monitoring of the administration of driving tests. -recently, this procedure has been validated for a large group people across a wide range of ages that manifested a variety of medical conditions; -new course for road-test was developed and validated against an off-road (in office) test battery; -important feature of this test is that by identifying the attributes of a road course that reveal competence-defining driving errors of medically impaired drivers, criteria for "unsafe to drive" meet the requirements of the Supreme Court of Canada's ruling concerning 'reasonable road safety'.
	Mallon & Wood (2004)	Queensland University of Technology, Brisbane, Australia	-similar to PDE of Odenheimer et al. (1994) with the addition of self-directed navigational component to highlight difficulties of older drivers; -15 km, predetermined route in city and suburban streets, with simple and complex intersections, and a range of traffic densities; -operational maneuvers are performed at pre-designated locations; - a spectrum of situations that drivers would typically encounter when they interact with traffic on a daily basis; -for 16% of locations, the participant was asked to find her/his way to specific destination

			(self-directed navigation task), requiring the participant to actively engage in multiple tasks involving visual scanning, divided attention, planning and judgment; -all their groups (differing by age and visual impairment) performed better when followed directions, all showed more errors under self-directed navigation and errors in self-directed navigation increased by age and visual impairment; -as yet unknown whether the task will discriminate between healthy and impaired drivers
Behind-the-wheel Driving Performacne Assessment	Justiss et al. Velozo, (2006)	National Older Driver Research and Training Centre, University of Florida	-driving behaviors (vehicle position, lane maintenance, speed regulation, yeilding, signaling, visual scanning, adjustment to stimuli and gap acceptance) on a fixed route with low, moderate and high grades of maneuver complexity - scored from 0 (physical intervention required) – 3 (no errors -examined criterion validity, interrater reliability, internal consistency, and test-retest reliability

REFERENCES

American Medical Association (2003). *Physicians guide to assessing and counseling older drivers.* Retrieved 20 December 2007.

Anstey, K. J., Wood, J., Lord, S., & Walker, J. G. (2005). Cognitive, sensory and physical factors enabling driving safety in older adults. *Clinical Psychology Review, 25*(1), 45-65.

Ashman, R., Bishu, R., Foster, B., & McCoy, P. (1994). Countermeasures to improve the driving performance of older drivers. *Educational Gerontology, 20*(6), 567-577.

Association, A. M. (2003). *Physicians guide to assessing and counseling older drivers.* Retrieved 20 December 2007.

Baldwin, K. C., Duncan, D. D., & West, S. K. (2004). The driver monitor system: A means of assessing driver performance. *Johns Hopkins APL Technical Digest, 25*(3), 269-277.

Brouwer, W., & Van Zomeren, E. (1992, Oct 5-6). *Evaluation of driving in traumatically brain-injured persons.* Paper presented at the Second International Congress on Objective Evaluation in Rehabilitation Medicine, Montreal, Canada.

Brown, L. B., & Ott, B. R. (2004). Driving and dementia: A review of the literature. *Journal of Geriatric Psychiatry and Neurology, 17*(4), 232-240.

Carr, D., Jackson, T. W., Madden, D. J., & Cohen, H. J. (1992). The effect of age on driving skills. *Journal of the American Geriatrics Society, 40*(6), 567-573.

De Raedt, R., & Ponjaert-Kristoffersen, I. (2000). Can strategic and tactical compensation reduce crash risk in older drivers? *Age and Ageing, 29(6),* 517-521.

Dobbs, A. R. (2005, June 5-8). *The development of a scientifically based driving assessment and standardization procedures for evaluating medically at-risk drivers* Paper presented at the Canadian Multidisciplinary Road Safety Conference XV, Fredericton, NB.

Dobbs, A. R., Heller, R. B., & Schopflocher, D. (1998). A comparative approach to identify unsafe older drivers. *Accident Analysis and Prevention, 30*(3), 363-370.

Dubinsky, R. M., Stein, A. C., & Lyons, K. (2000). Practice parameter: risk of driving and Alzheimer's disease (an evidence-based review): report of the quality standards subcommittee of the American Academy of Neurology. *American Academy of Neurology, 54,* 2205-2211.

Duchek, J. M., Carr, D. B., Hunt, L., Roe, C. M., Xiong, C., Shah, K., et al. (2003). Longitudinal driving performance in early-stage dementia of the Alzheimer type. *Journal of the American Geriatrics Society, 51*(10), 1342-1347.

Eby, D. W., Trombley, D. A., Molnar, L. J., & Shope, J. T. (1998). *The assessment of older drivers' capabilities: A review of the literature*: University of Michigan: Transportation Research Institute.

Fitten, L. J., Perryman, K. M., Wilkinson, C. J., Little, R. J., Burns, M. M., Pachana, N., et al. (1995). Alzheimer and vascular dementias and driving - a prospective road and laboratory study. *Journal of the American Medical Association, 273*(17), 1360-1365.

Fox, G., Bowden, S., & Smith, D. (1998). On-road assessment of driving competence after brain impairment: Review of current practice and recommendations for a

standardized examination. *Archives of Physical Medicine and Rehabilitation, 79*, 1288-1296.

Hunt, L. A., Murphy, C. F., Carr, D., Duchek, J. M., Buckles, V., & Morris, J. C. (1997). Environmental cueing may affect performance on a road test for drivers with dementia of the Alzheimer type. *Alzheimer Disease & Associated Disorders, 11*, 13-16.

Johansson, K., & Lundberg, C. (1997). The 1994 International Consensus Conference on Dementia and Driving: A brief report. *Alzheimer Disease & Associated Disorders, 11*, 62-69.

Jones, M. (1978). *Driving performance measures for safe performance curriculum* (No. 78-3). Los Angeles: University of Southern California.

Justiss, M. D., Mann, W. C., Stav, W., & Velozo, C. (2006). Development of a behind-the-wheel driving performance assessment for older adults. *Topics in Geriatric Rehabilitation, 22*(2), 121-128.

Korner-Bitensky, N., Bitensky, J., Sofer, S., Man-Son-Hing, M., & Gelinas, I. (2006). Driving evaluation practices of clinicians working in the United States and Canada. *American Journal of Occupational Therapy, 60*(4), 428-434.

Korner-Bitensky, N., Gelinas, I., Man-Song-Hing, M., & Marshall, S. (2005). Recommendations of the Canadian Consensus Conference on driving evaluation in older drivers. *Physical & Occupational Therapy in Geriatrics, 23*(2/3), 123-144.

Kua, A., Korner-Bitensky, N., Desrosiers, J., Man-Son-Hing, M., & Marshall, S. (2007). Older driver retraining: A systematic review of evidence of effectiveness. *Journal of Safety Research, 38*(1), 81-90.

Mallon, K., & Wood, J. M. (2004). Occupational therapy assessment of open-road driving performance: Validity of directed and self-directed navigational instructional components. *American Journal of Occupational Therapy, 58*(3), 279-286.

Marottoli, R. A., Richardson, E. D., Stowe, M. H., Miller, E. G., Brass, L. M., Cooney, L. M., et al. (1998). Development of a test battery to identify older drivers at risk for self-reported adverse driving events. *Journal of the American Geriatrics Society, 46*(5), 562-568.

McCoy, P., Tarawneh, M., Bishu, R., Ashman, R., & Foster, B. (1993). Evaluation of countermeasures for improving driving performance of older drivers. *Transportation Research Record, 1405*, 72-80.

McKenna, P., Jefferies, L., Dobson, A., & Frude, N. (2004). The use of a cognitive battery to predict who will fail an on-road driving test. *British Journal of Clinical Psychology, 43*, 325-336.

Medicine, A. S. f. G. (2003). Australian Society for Geriatric Medicine Position Statement No. 11. Driving and dementia. *Australian Society for Geriatric Medicine, 22*, 46-50.

Odenheimer, G. L., Beaudet, M., Jette, A. M., Albert, M. S., Grande, L., & Minaker, K. L. (1994). Performance-based driving evaluation of the elderly driver: Safety, reliability, and validity. *Journal of Gerontology. Medical Sciences, 49(4)*, M153-159.

Ostrow, A., Shaffron, P., & McPherson, K. (1992). The effects of a joint range-of-motion physical fitness training program on the automobile driving skills of older adults. *Journal of Safety Research, 23*(4), 207-219.

Patterson, C., Gauthier, S., Bergman, H., Cohen, C., Feightner, J., Feldman, H., et al. (2001). The recognition, assessment and management of dementing disorders - conclusions from the Canadian Consensus Conference on Dementia. *Canadian Journal of Neurological Sciences, 28*(Suppl 1), S3-S16.

Pietrapiana, P., Tamietto, M., Torrini, G., Mezzanato, T., Rago, R., & Perino, C. (2005). Role of premorbid factors in predicting safe return to driving after severe TBI. *Brian Injury, 19*(3), 197-211.

Porter, M. M., & Whitton, M. J. (2002). Assessment of driving with the global positioning system and video technology in young, middle-aged, and older drivers. *Journals of Gerontology Series a-Biological Sciences and Medical Sciences, 57*(9), M578-M582.

Rizzo, M., Jermeland, J., & Severson, J. (2002). Instrumented vehicles and driving simulators. *Gerontechnology, 1*(4), 291-296.

Rizzo, M., McGehee, D. V., Dawson, J. D., & Anderson, S. N. (2001). Simulated car crashes at intersections in drivers with Alzheimer disease. *Alzheimer Disease and Associated Disorders, 15(1),* 10-20.

Rizzo, M., Reinach, S., McGehee, D., & Dawson, J. (1997). Simulated car crashes and crash predictors in drivers with Alzheimer disease. *Archives of Neurology, 54*(5), 545-551.

Rudman, D. L., Friedland, J., Chipman, M. L., & Sciortino, P. (2006). Holding On and Letting Go: The Perspectives of Pre-seniors and Seniors on Driving Self-Regulation in Later Life. *Canadian Journal on Aging, 25*(1), 65-76.

Schultheis, M., Hillary, F., & Chute, D. (2003). The Neurocognitive Driving Test: Applying technology to the assessment of driving ability following brain injury. *Journal of Head Trauma Rehabilitation, 17*(1), 38-47.

The British Psychological Society (2001). *Fitness to drive and cognitive: A document of the multidisciplinary working party on acquired neuropsychological deficits in fitness to drive 1999*. Leicester.

Whelihan, W. M., DiCarlo, M. A., & Paul, R. H. (2005). The relationship of neuropsychological functioning to driving competence in older persons with early cognitive decline. *Archives of Clinical Neuropsychology, 20*(2), 217-228.